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ABSTRACT

"Computer-Supported Intentional Learning Environments" (CSILE) is an educational philosophy developed by M. Scardamalia and C. Bereiter (1991) for the design of computer-supported learning environments. CSILE software is a communal database system in which learners are allowed to externalize their thoughts as text or graphic "notes," and then organize their knowledge collaboratively to advance their communal understanding. A web-based version of CSILE (WebCSILE) was used in university courses in Japan to explore the effects of CSILE on learning with a Japanese student population. The study examines the frameworks of discourse in learning communities with and without instructional scaffolding to determine the additional support novices might need as they used CSILE. Participants were groups of 30 and 24 Japanese undergraduates. Students used WebCSILE as a tool in collaborative discourse, and its use appeared to expand their communication and collaboration. However, providing scaffolding seemed to students to be supplying tasks that they had to complete by specific dates. Instructional interventions were thus transformed into simple tasks. Some suggestions are made for improved use of CSILE in the Japanese context. (Contains 2 tables, 6 figures, and 20 references.) (SLD)

# Scaffolding for progressive discourse in CSILE: Case study of university undergraduate programs

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## Background

"Computer-Supported Intentional Learning Environments (CSILE)" proposed by Scardamalia, Bereiter, and their colleagues is an educational philosophy for the design of computer-supported learning environments (Scardamalia, & Bereiter, 1991, 1993, 1994, 1996; Scardamalia, Bereiter, Brett, Burtis, Calhoun, & Smith-Lea, 1992; Scardamalia, Bereiter, & Lamon, 1994; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). CSILE software (i.e., regular CSILE™ 1.5 and Knowledge Forum™) is a communal database system in which learners are allowed to externalize their thoughts mainly in the form of texts or/and graphics called "notes," then engage in collaboratively organizing their knowledge as objects to advance their communal understanding as a whole. This communal database structure has been found to provide learners with opportunities to be involved in knowledge advancement through distribution of their expertise (e.g., Oshima, Bereiter, & Scardamalia, 1995; Oshima, Scardamalia, & Bereiter, 1996), and to eventually facilitate learners' conceptual understanding of complex scientific phenomena in comparison with traditional instructions (e.g., Scardamalia et al., 1992). Thus, empirical studies so far have shown that CSILE is a powerful tool to transform learning activities to knowledge building.

The study reported here is a part of our research project that have continued for three years since 1996. We deployed WebCSILE (i.e., WWW version of CSILE) in university programs in Japan to explore the generic effects of CSILE on learning. CSILE has been developed in Western culture, and used in schools that have Western cultural background. Whereas studies have shown that CSILE has positive effects on learning in the school system, the findings may be limited in the specific cultural background. Students in Western classrooms have opportunities in the curriculum to express themselves and participate in discussion. On the other hand, in Japan, there is no established curriculum on discussion skills although such skills are currently being paid attention to in their education. Based on the differences in discussion skills between the two cultures, we may infer that CSILE would work in cultures where discussion or discourse is regarded important. However, in cultures where the skills are not developed through educational practices, CSILE may not work for knowledge advancement. For the purpose, we have set CSILE sites in Japan then investigated how learners make use of the information technology and necessary conditions for its successful use.

In our previous studies (Oshima, & Oshima, in press), we deployed WebCSILE system in expert learners' activities (i.e., graduate programs) to see how the learners use WebCSILE and recognize it as a tool for knowledge advancement. Then, we further set up another WebCSILE site for novice learners (i.e., undergraduates) based on results from the study of experts. Studies of experts showed that expert learners like graduate students recognized WebCSILE as a new communication channel, then assigned different roles in synchronous and asynchronous communications. In particular, the learners used their synchronous communication channel, i.e., face-to-face communication, for coordinating their discourse on WebCSILE. The learners reported in our interview that they could expand their communication among members in the class by using WebCSILE, and that they had been aware of the importance of asynchronous communication for reflecting on their and others' previous thoughts.

Currently, we are further expanding the target learners in our research to novice learners, i.e., undergraduates in universities. The aims of the study are to report our attempt of the deployment of WebCSILE in novice learners' activities and to discuss crucial factors to successful use of WebCSILE for the purpose of improving knowledge advancement by novice learners. Particular study questions are: (1) how novice learners utilize WebCSILE in their learning, e.g., their recognition of synchronous and asynchronous communication channels, (2) what is missing in comparison with experts, and (3) what resources could be implemented for facilitating ideal use of WebCSILE by novices.

**Progressive discourse as knowledge advancement**

With language as a cognitive tool, ones can attain knowledge or understanding as social agreements in a community (Roschelle, 1992). However, knowledge advancement, which we think is important in learning organizations in particular, is not frequently happening in ordinary discourse. As Bereiter (1994) argued, progressive discourse in science must satisfy several conditions and commitments. A key commitment by participants is their recognition of knowledge as object (Bereiter, 1994; Popper, 1972; Scardamalia, & Bereiter, 1993). The recognition of knowledge as object by scientists produces specific frameworks of discourse (e.g., Eichinger, Anderson, Palincsar, & David, 1991). This study examined frameworks of discourse in communities with and without instructional scaffoldings to particularly figure out what further support is needed for having novice communities engage in progressive discourse through which they may develop as learning organizations.

## Design experiment approach

For describing and evaluating learners' activities supported in WebCSILE, we take the "design experiment approach (e.g., Brown, 1992; Collins, 1990)." As Brown (1992) argues, it is not strictly possible for educational researchers to control a variety of variables or factors in educational settings to figure out effects of the individual variables on educational outcomes. Educational practices are dynamic activities in which a variety of critical factors are interacting with one another. Since effects on educational outcomes come from interactions among the variables, what we have to consider are not changes in individual variables but interactive relationships among the variables and their consequences. Therefore, strict manipulation of variables in such dynamic activities may often disturb appropriate interactions among the variables, then the outcomes are not necessarily what we would like to investigate on. This study, in particular, investigates two different communities in different contexts supported by CSILE. The use of CSILE and its effects totally depends on how CSILE is utilized with the users' schedule or intentions. We, therefore, are concerned with how to improve each practice by designing activities supported by CSILE rather than with what individual factors affect what performance measures.

## Design of learning environments

We need a reference based on which we are going to evaluate our learning environment supported by WebCSILE. Here, we refer to characteristics in learning environments proposed by Collins, Brown, and Newman (1989). The framework of learning environments by Collins et al. consists of four major characteristics: (1) content, (2) method, (3) sequencing, and (4) sociology. In the content, various types of knowledge including domain knowledge are targeted. Collins et al. emphasize that traditional classrooms underestimate heuristics, metacognitive knowledge, and learning strategies. In the method, they also argue necessary changes in instructional methods according to target knowledge we like to develop in learners. Particularly, they emphasize the need of modeling expert performance, scaffolding learners' performance, and reflection by learners themselves. In the sequencing, it is argued that the increase in complexity and diversity of tasks are crucial. In the sociology, they argue that meaningful contexts of learning, i.e., authentic learning, is crucial and that culture of expertise should be developed through exploiting cooperation.

In this study, we attempted to set undergraduate course curricula for improving students' knowledge advancement. For this purpose, particularly metacognitive knowledge and learning strategies were focused as targets of our learning environment design. Learning was self-directed in most part of the curricula, and students were encouraged to collaborate through WebCSILE communication. The tasks we gave were global, complex, and diverse enough so that learners could approach in a variety of ways. Further, we emphasized the importance of collaboration for knowledge advancement, particularly collaborative discourse.

## Study Description

### Study design

As stated in the above, we took design experiment approach in this study. Two studies reported here were parts of our design experiments to deploy WebCSILE in communities of novice learners. Study 1 described how novice learners recognized and utilized WebCSILE without any specific scaffoldings in instructional methods except for conditions stated above. The aim of Study 1 was to figure out what are needed for improving novices' knowledge advancement. In Study 2, we attempted a scaffolding technique for improving their progressive discourse based on results from Study 1.

### Participants

Participants in the two studies were undergraduate students who took courses taught by one of the authors (Jun Oshima) in academic years of 97 and 98. In Study 1, thirty sophomores participated in a course titled "Basics in Cognitive Science." In Study 2, twenty-four sophomores participated in another course titled "Computing in Education." Both groups of students were from the same major program in the same university in two different years. We assumed that their academic levels were almost equal between the groups.

### Learning contexts

Both courses continued for a semester (about three months and a half). Since it was found from the results of our expert studies that coordination of different communication channels was one of key activities for improving knowledge advancement, we scheduled ordinary class meetings once a month for lecture, providing materials, and discussion for WebCSILE communication. In Study 1, the task for the students in the course was to comprehend basics in cognitive science, particularly learning theories and education. The professor introduced one chapter of a seminal book on learning and instruction (Resnick, ed., 1989) in each ordinary class meeting. The students were required of expressing their understanding and questions on the introduced topics, and helping each other in advancing their knowledge. Final assignment for them was to write a proposal report in which they should describe what problems they thought were there in the introduced studies and how they thought could overcome the problems by experiments.

In Study 2, the task for the students in the course was to synthesize ideas of "computing in education" curriculum in Japanese school system found in WWW homepages, and to propose further ideas to promote the curriculum. They were assumed to consider learning from various points of views. There were many homepages on "computing in education." Some described theoretical issues on learning with computers, and others reported and discussed practices conducted by teachers at various levels of schooling, such as elementary, junior high, senior high, and university. The students were required of searching for homepages on WWW to find materials that they thought were valuable to discuss, and reporting the contents in a specific argument framework so that others could fully understand them. As a scaffolding, we prepared a help homepage in which students could refer to how to write their thoughts during discourse, such as commenting (positively or critically), adding some new thoughts, and so on. This page was linked with the top page for the course so that students could access at anytime they needed help in writing their notes. The professor set ordinary class meetings once a month as in Study 1 for discussing progress in discourse on WebCSILE and answering questions from the students.

**WebCSILE-based system for the course**

We set up a World Wide Web (WWW) server for WebCSILE at the authors' university site. WebCSILE is a WWW version of CSILE. The network architecture is shown in Figure 2. Although functionalities in WebCSILE were limited in comparison with those of the regular CSILE 1.5, it could be used more widely across different sites with clients across Windows™ and Macintosh™ platform. Since most of the participants in this study had Windows™ machines and had to access CSILE through Internet, we decided to use WebCSILE rather than the regular CSILE 1.5. Another reason for the use of WebCSILE was that it was compatible with Japanese environment.

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Insert Figure 1 about here

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Students could access WebCSILE through WWW if they had Internet access. Figure 2 shows the first page on the Web. The participants were required of typing in their username and password, then click on "Sign On" button. Next, they were given a topic page shown in Figure 3. There were topics for four different communities since they shared one database. The participants in each community had to choose one of them to contribute to their community. Finally, they could see the title window in which related notes were structured in threads as default. They could change the view among "thread," "author," and "date" options. The "author" view was a list of notes sorted by authors, and the "date" view was a list sorted by dates from most recent one. Thus, each view provided the participants with different information of the database.

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Insert Figure 2 and 3 about here

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After signing on, students could report their thoughts at any window. The left side of the window showed possible options of their actions. Students could type in their thoughts as new notes or comments on others' thoughts. In the text area, they could use HTML. If they were familiar with HTML, they could visually elaborate their notes. Furthermore, they could put their graphical information in their personal folders so that they could link the graphics in their HTML area of their notes. In addition to its multimedia nature of notes, WebCSILE had another functionality to support participants to move between notes. Figure 4 shows an example of WebCSILE note. WebCSILE note had two different hyper links automatically created by cgi scripts. One type of the links was "references." This was a metaphor from journal papers. Students could jump to the target note on which the note commented. The other type of links was unique in the hypertext structure of WWW, "notes that refer to this note." This link took students to notes that referred to the original notes. Thus, in WebCSILE, students' manipulation of asynchronous discourse was supported by its hypertext natures as well as its database functionalities.

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Insert Figure 4 about here

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**Data**

*Contents in reported notes.* Contents written by students were printed, and evaluated from two different perspectives by two different groups of persons: (1) quality of progressive discourse evaluated by two professors whose majors are in cognitive science and computing in education, and (2) argument framework of discourse by three independent raters (two authors and one graduate student).

In this study, we were particularly concerned with notes creating threads on WebCSILE since thread notes were considered as collaborative discourse in which students were clearly exchanging ideas and thoughts. Two cognitive scientists were asked to evaluate each thread with a 10-point scale of how progressive the target discourse was. The scientists were told to refer to conditions of progressive discourse proposed by Bereiter (1994). They were instructed to focus their evaluations on progress in discourse rather than content knowledge. Correlations between the scientists' evaluations reached at significant levels ($r$ = .41138, p < .05), then we calculated average scores as progressive discourse scores of threads.

Furthermore, the same contents were evaluated from another point of view, argument framework. Toulmin's framework of the argument has been applied to collaborative learning research for describing what's going on in students' discourse, or for figuring out how similar to or far from scientific discourse children's discourse is. Eichinger et al. (1991), for instance, investigated on how elementary school students managed their ideas through their collaboration in problem solving, then how their discourse looked like based on the argument framework by Toulmin. The results showed that patterns of progress in the discourse were critically different from by scientists. Elementary school students attempted to defend their own claims then attack others'. On the other hand, in the scientists' discourse, they did not have specific claims in the initial stage of their discourse. Rather, they qualified their tasks from a variety of points of views, and collaboratively considered warrants and backups for each possible claim. Thus, discourse by the experts was found to be socially constructed through distributed expertise, then this aspect was found to be crucial to scientific discourse.

Although the argument framework by Toulmin was a useful tool for us to describe how written discourse was going on in WebCSILE, we had some difficulties in applying the framework to our data. First, our data was written discourse in university courses, and the tasks were ill-structured. The task used in Eichinger et al. (1991), for instance, was "which state of water is best to bring into the space." The students were asked to solve this problem after learning appropriate scientific knowledge on the matter. The tasks for our students were to advance their knowledge through their discourse on reading assignments or their existing expertise. Because of the natures of the tasks, it was difficult for us to describe all alternatives of possible claims. The claims possible to raise were unlimited, and problem spaces our students were engaged in continuously changed. For these reasons, we considered the participants' discourse as further discourse based on the discourse in reading assignments and other available resources. The authors and one graduate student as a research assistant read reading assignments in each community then evaluated thread notes in WebCSILE as discourse on the discourse in the reading assignments.

Second, since the tasks students in this study engaged in were not to decide one of alternative claims on a problem as a correct answer but to create claims, streams of their discourses were multi-dimensional. Therefore, we described how new claims were related to previous discourse.

Third, since arguments in the discourse were socially constructed through collaboration, the students sometimes requested others specific components of the argument framework, such as claims ("What do you think of this?"), qualifications ("Does anybody know well about this?"), and backups ("Does anybody have data or evidence?"). We added these requests as components of the argument framework.

*Questionnaire data.* Questionnaires which asked students about their recognition of the courses using WebCSILE and problems they had during the courses were conducted in the middle and the end of the courses. In the second questionnaire, we added a simple question "Whom did you talk to over this course?

Please write down their names up to five persons" to create communication maps off line.

### Analysis plan

Data analysis was first conducted for comparing qualities and argument framework of students' progressive discourse between the two classes with and without scaffolding for argument. This analysis was for testing whether our scaffolding worked well for improving students' progressive discourse. Then, we further conducted multi-regression analyses to investigate relationships between the qualities of progressive discourse and frameworks of argument in threads.

## Results

*Demographic data*. First, we describe some demographic data. In Study 1, thirty students created 165 notes total. One-hundred and six notes (64.24%) appeared in threads. Other 59 notes were single ones which did not have any commentaries. The difference in proportions of thread and single notes created by students was significant in that thread notes were more likely created by students, $\chi^2(1) = 13.39$, $p < .05$. As participation indices, we further analyzed numbers of notes read and written by students. 24.9% of single notes and 31.1% of thread notes (excluding their own notes) on the average were read by students. 1.9 single notes and 3.4 thread notes on the average were created by students. *t*-tests on mean numbers of notes showed that students were more likely to read thread notes, $t(29)=-3.7959$, $p < .01$, but equally created single and thread notes.

In Study 2, twenty-four students created 145 notes total. One-hundred and nine notes (75.17%) appeared in threads. Other 36 notes were single ones which did not have any commentaries. The difference in proportions of thread and single notes created by students was significant in that thread notes were more likely created by students, $\chi^2(1) = 36.75$, $p < .05$. As participation indices, we further analyzed numbers of notes read and written by students. 35.9% of single notes and 42.8% of thread notes (excluding their own notes) on the average were read by students. 1.4 single notes and 4.4 thread notes on the average were created by students. *t*-tests on mean numbers of notes showed that students were more likely to read thread notes, $t(23)=-2.386$, $p < .05$, but equally created single and thread notes.

As far as we looked at the demographic data, both communities of students as a whole acted on WebCSILE quite similarly. Both communities were more likely to focus on thread notes which we regarded as discourse on-line in this study. Next, we are going to see whether progressive discourse did similarly happen between the communities from the perspectives of the qualities of discourse and of its argument framework.

*Evaluation of progressive discourse*. In Study 1, there were 31 threads. The average score by two scientists across the thread was 2.3 of 10 as maximum, ranged from 0.5 to 5.0. Fig. 5 shows proportions of threads assigned different scores. In Study 2, there were 37 threads. The average score was 1.8, ranged from 1.0 to 4.5. Fig. 6 shows proportional distribution of threads assigned different scores. Since frequency distributions of scores were quite skewed, we did not conduct any statistical analysis on mean scores. However, as seen in the distributions, it was found that more threads in Study 1 without any specific scaffolding for argument framework were highly evaluated. Thus, the result suggests that our scaffolding did not work for improving students' knowledge advancement.

Here, we have to consider a couple of possible reasons for the result. First reason for the result may be that students did not understand our instruction and, therefore, the argument framework did not develop as we had expected. We have to check whether our instructional intervention of argument scaffolding did work, i.e., whether students understood our instruction and utilized the help page on our homepage. Another reason may be that our assumption that an established argument framework is crucial to higher qualities of progressive discourse was not right. This possibility is going to be tested in the analysis of relationships between qualities of progressive discourse and its framework of arguments in the two studies.

*Descriptions of argument framework in discourse and its relations with the qualities of progressive discourse*. Discourse in each note was transformed into its argument framework by referring to Toulmin (1958) as stated in the preceding section. Table 1 shows frequencies of components of the argument framework appeared in notes in the studies. A chi-square analysis showed a significant difference in proportions of components between the studies, and suggesting that students in Study 2 produced more D, C, and W components, $\chi^2(8) = 54.65$, $p < .01$.

Table 1. *Frequencies of Components of Toulmin's Argument Framework.*

| | Components | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | D | Q | C | R | W | B | QR | CR | CoR |
| **Study1** | 8 | 24 | 12 | 5 | 6 | 1 | 8 | 6 | 0 |
| **Study2** | 37 | 17 | 29 | 8 | 20 | 1 | 7 | 2 | 0 |

Furthermore, we conducted multi-regression analyses to figure out which components of the argument were crucial to higher qualities of discourse. In Study 1, it was found that the components in totality explained a significant amount of variance, $F(8, 22)=4.5862$, $p < .01$. A further stepwise analysis manifested that particularly D and QR components were significantly contributing to the explained variance, *p*s < .05. In Study 2, as seen in Study 1, the components in totality explained a significant amount of variance, $F(7, 29)=3.8033$, $p < .01$. A further stepwise analysis manifested that C and Q components were significantly contributing to the explained variance, *p*s < .01.

*Students' recognitions on the use of WebCSILE.* Based on the data from our questionnaires conducted during the courses, we summarize changes in students' recognitions on their use of WebCSILE, and their own learning. As learning went on, the class was divided into three types of groups in Study 1. One was "learning goal-oriented group (Ng, & Bereiter, 1991)" which was frequently engaged in the written discourse to understand the contents in the course. In the questionnaire, they reported their recognition on the importance of the asynchronous communication tool, monitoring their own learning, and problems with their learning activities to effectively use the technology. There was a transitional group which was sometimes engaged in the written discourse. In the questionnaire, the transitional group reported difficulties in using the technology to make their learning more productive, and their reflections on their own learning. Final group consisted of participants who rarely participated in the written discourse. In the questionnaire, they reported how problematic it was for them to access the homepage for the course, but they did not have reflections on their own learning.

Thus, in Study 1, the learning goal-oriented and the transitional groups made use of WebCSILE as a tool for knowledge advancement. Through the new asynchronous communication channel, they succeeded in expanding their learning community. They became to recognize that learning through collaboration with others was crucial to knowledge advancement. However, the third "task goal-oriented group" was not aware of learning as knowledge construction. They did not think that communication with others led them to further advancement of knowledge.

Unlike we expected, students in Study 2 did not report any recognition on their own learning. Their recognitions were quite similar to those by the task goal-oriented group in Study 1. Although they told that they thought that the type of instruction with the use of the computer-network was worth to do for their learning, their reports were quite abstract and superficial.

*Communication matrices on- and off-line.* The second questionnaire had a section which asked students to make a list of persons (up to five) whom they had communicated with in face-to-face contexts. Based on the data, we created communication matrices in the face-to-face context, i.e., who communicated with whom. Similarly, we created communication matrices on-line, i.e., who commented on whom. By combining the two types of matrices, we finally created global communication matrices. In Study 1, less than one per cent of communication relations overlapped in the face-to-face and the on-line context, whereas, in Study 2, about 42% of communication relations did so.

## Discussion

*How did novice learners utilize WebCSILE in their learning?* At the level of performance on-line, undergraduate students did seem to utilize WebCSILE as a tool for their collaborative discourse. They were more likely to read thread notes, which suggests that they were likely to participate in collaboration rather than expressing themselves. Furthermore, the analysis of communication matrices showed us that their communication patterns on-line were quite different from those off-line. This suggests us that they were engaged in the discourse on-line in a different manner than that off-line. As we imagine, students had already created some cohorts in the class. There were not students who *euqally* communicated with others. The presence of the cohorts are considered to have affected their communications off-line. The darastic differences in the patterns between on-line and off-line suggest that WebCSILE have successfully expanded the students' communications with others whom they had rarely communicated before.

With regard to the argument framework of discourse on WebCSILE, the comparisons of the frameworks between the studies showed that students who used our scaffolding homepage for the argument created more elaborate argument frameworks in their discourse. Students in Study 2 created basic components of discourse (data, claim, and warrant) singinifcantly more than students in Study 1. The result suggests us that the instruction we gave the students worked.

Then, how about contents in their discourse? Was it progressive? In our previous studies (Oshima, J. & Oshima, R., in press; Oshima, R., 1999), we compared the qualities of discourse by experts and novices (in Study 1). As expected, the discourse by the experts had significantly higher scores by two scientists than the novices. One remarkable point in this study was that novices who did not receive the scaffolding produced more highly-evaluated threads, i.e., discourse, than did those who did receive the scaffolding. The result was unexpected, then this is going to be further discussed in the following subsections.

*What is missing in novices?* What we found from the comparisons between the experts and the novices (in Study 1) were: (1) that the novices did not develop control starategies and learning strategies for knowledge advancement, and (2) that the novices' motivations for learning were not necessarily oriented by knowledge building goals. Students in Study 1 reported difficulties in managing their own learning and writing their ideas in WebCSILE notes. Therefore, we implemented a schedule for WebCSILE activities and a scaffolding homepage for helping students in writing their ideas in the scientific manner. We expected that the qualities of discourse by students in Study 2 improved much better than that by students in Study 1. However, as we stated in the preceding section, we found that the discourse by Study 2 students were not qualified as higher. These results suggest that the argument framework itself is not sufficiently crucial to knowledge advancement in discourse although we still believe that the argument framework is necessary in scientific discourse.

Study 2 students' reports in questionnaires give us some hints for reasons that the scaffolding did not lead the students to higher qualities of discourse for knowledge advancement. Their reports did rarely describe learning or knowledge building goals-oriented evaluations. They did seem to just follow our instruction to complete tasks they recognized during the course. The contents in their reports were quite similar to those by students oriented by the task-goal seen in Study 1. Furthermore, in reading their notes on WebCSILE, we realized a critical difference in discourse between students in Study 1 and Study 2. That was the presence of metadiscourse in Study 1. In their discourse, students in Study 1 struggled with creating some forms of discourse which could be shared with others. They did not create elaborate frameworks of arguments, but discuss the contents at the metacognitive level. There were found to be *reasons* for manipulating their own and others' thoughts in discourse. They described why they commented on others' thoughts, how they created their forms of discourse, and so on. Surprisingly, such discourse were rarely found in Study 2 students'. We ambiguously expected that they could manipulate their thoughts in such a metacognitve way when they were given soecific forms of discourse. This did not work. They did seem to recognize our scaffolding as tasks which they had to complete by specific dates. Our instructional interventions were easily transformed into simple tasks.

*Lessons: What resources could be implemented for facilitating ideal use of WebCSILE by novices?* Based on the charatceristics of the ideal learning environment proposed by Collins et al. (1989), the learning environment we developed is described in Table 2.

Table 2. *Current State of Our Developed Learning Environment with WebCSILE.*

| Characteristics | Current State of Our Developing LE |
|---|---|
| **Content** | |
| Domain Knowledge | Target domain knowledge |
| Huristics Strategies | n.a. |
| Control Strategies | Metadiscourse developed by learners |
| Learning Strategies | n.a. |
| **Method** | |
| Modeling | n.a. |
| Coaching | Instructor's participation in discourse |
| Scaffolding | Help homepage |
| Articulation | n.a. |
| Reflection | Discussion in the face-to-face class |
| Exploration | Self-directed learning |
| **Sequencing** | |

| | |
|---|---|
| Increasing Complexity | Ill-structured problem contexts |
| Increasing Diversity | Ill-structured problem contexts |
| Global Before Local Skills | Global problems |
| **Sociology** | |
| Situated Learning | n.a. |
| Culture of Expert Practice | Theory or curriculum construction |
| Intrinsic Motivation | n.a. |
| Exploiting Cooperation | WebCSILE communication |
| Exploiting Competition | n.a. |

Based on the current state of our developing LE by referring to Collins et al. (1989), we are going to discuss two issues: (1) whether or not our implementation of the learning environment in undergraduate courses worked as we expected, and (2) what we can do to revise our implementation of LE characteristics and to deploy other characteristics which we had not implemented.

*Did our implementation of the LE characteristics work as expected?* Regarding the content, metacognitive aspects of progressive discourse, i.e., control strategies, were not developed well by students themselves. Unlike our expectation, providing the argument framework in discourse did not lead the students to higher qualities of discourse. Rather, the framework led the students to task goal-oriented. We need to consider to revise our implementation of instructional methods to facilitate more metadiscourse either on- or off-line. Coaching and scaffolding did not seem to be sufficient enough. The instructor participated in some threads to implicitly direct discourse by giving some requests for qualification and claims. However, he did not sufficiently focus on metacognitive aspects of discourse or did not request students to engage in such aspects of their own discourse.

*What can we do to improve our developing LE?* In addition to the revision of current characteristics of our developing LE, we are currently thinking of further implementation of characteristics. First, we are planning to implement modeling and articuation methods for facilitating metacognitive discourse. Students in the future LE will be allowed to access thread notes in previous databases which scientists highly evaluated to see how previous students engaged in progressive discourse. Furthermore, the instructor will attempt to collaboratively discuss with students why the previous thread notes were highly evaluated by scientists and why the type of discourse is valuable for knowledge advancement. Second, we are planning to challenge to intirinsically motivate students in the class through collaborative decision-making process with students of how to pursue our global problems during courses. In our studies so far, although problems were complex and diverse enough, and students were allowed to self-direct their learning, materials such as reading assignments were predetermined by instructors. We will discuss with students how to approach our global problems and how authentically they can be involved in courses.

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**Figure Caption**

*Figure 1.* Network Architecture for WebCSILE.

*Figure 2.* The Window of WebCSILE top page through Netscape™.

*Figure 3.* The Window of Topic Page of WebCSILE through Netscape™.

*Figure 4.* The Window of a Student's Note in WebCSILE through Netscape™.

*Figure 5.* Proportional Distribution of Threads Assigned Different Scores in Study 1.

*Figure 6.* Proportional Distribution of Threads Assigned Different Scores in Study 2.

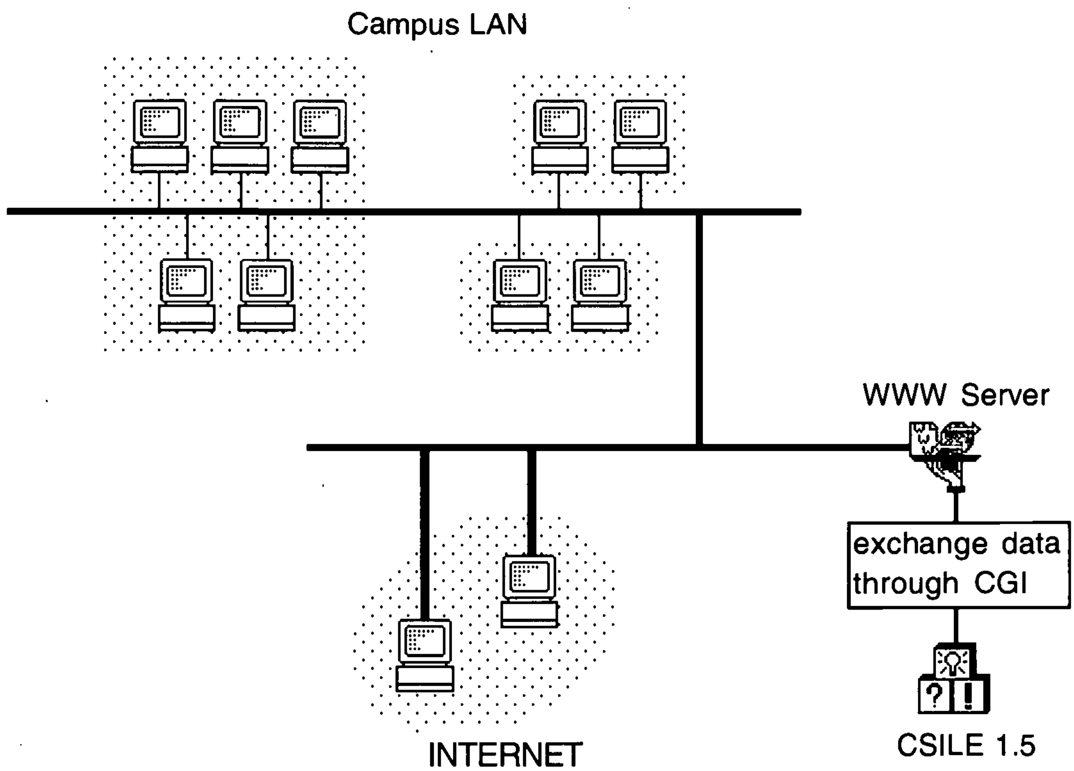
Campus LAN
WWW Server
exchange data through CGI
INTERNET
CSILE 1.5

Fig. 1.


Fig. 2.

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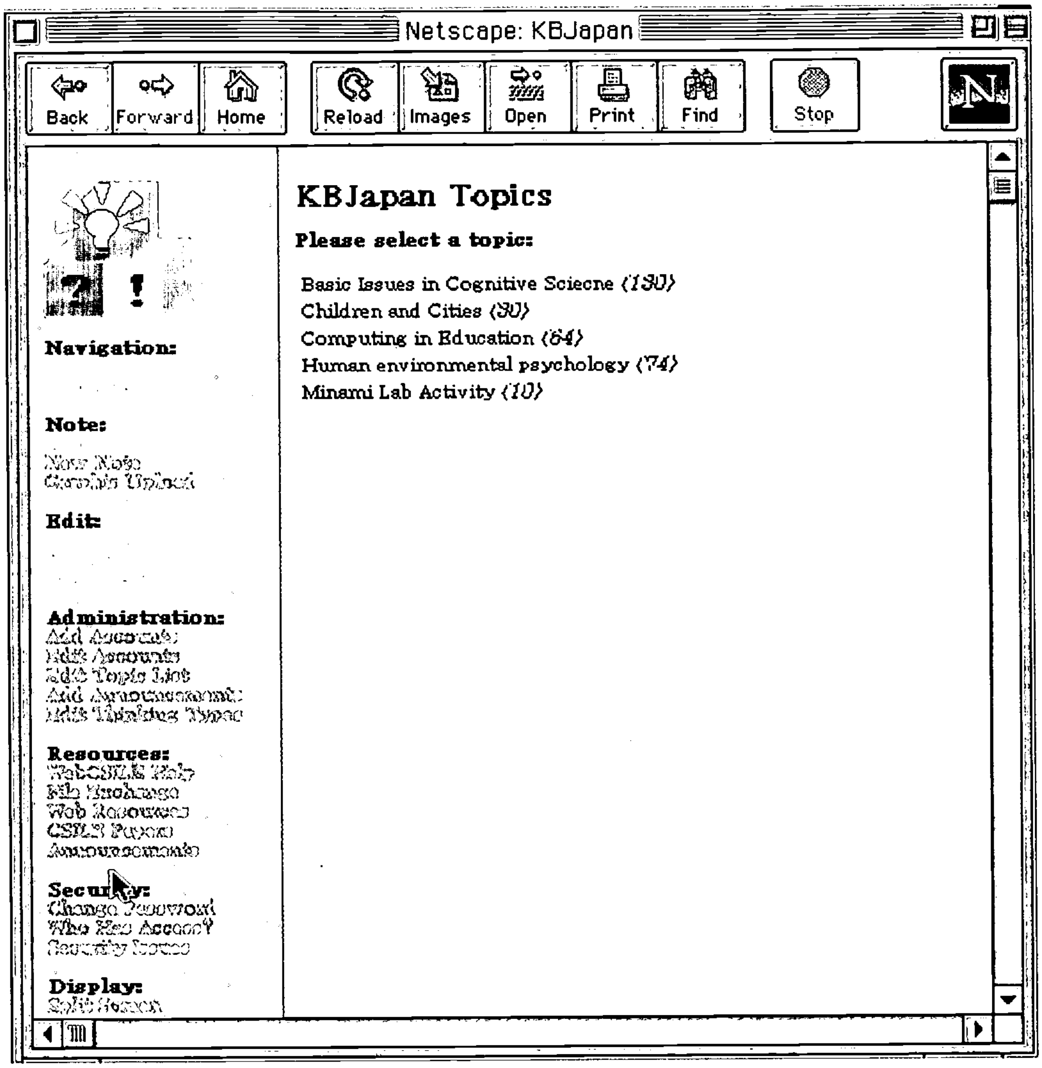


Fig. 3.

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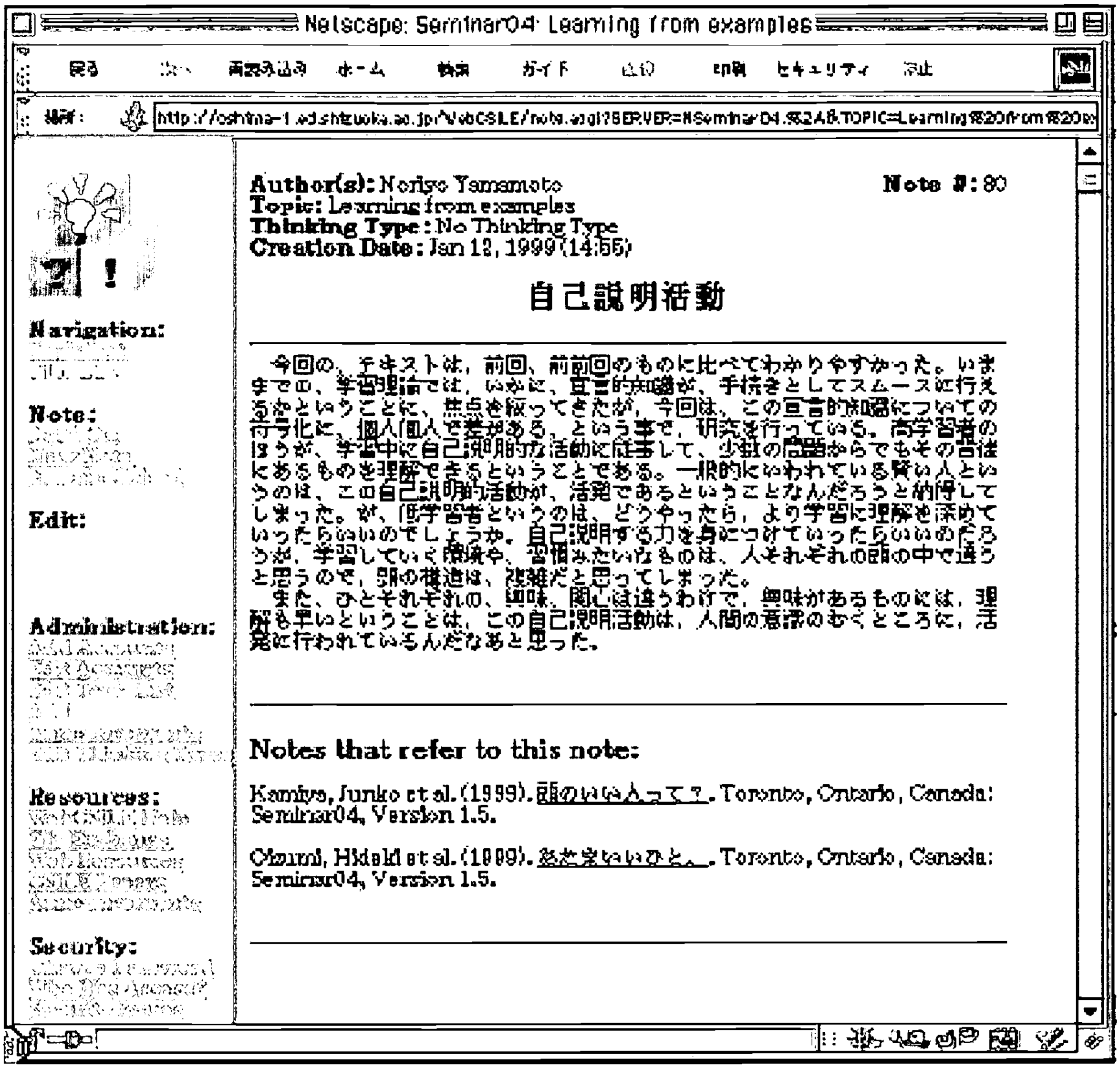


Fig. 4.

24



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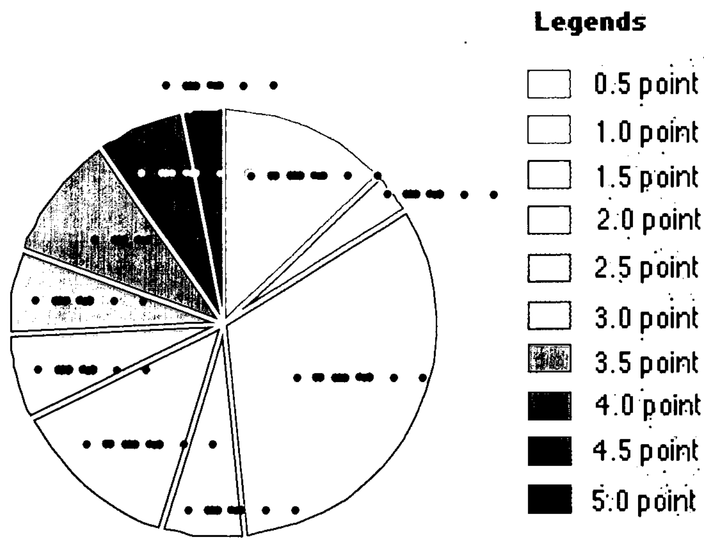


Fig. 5.

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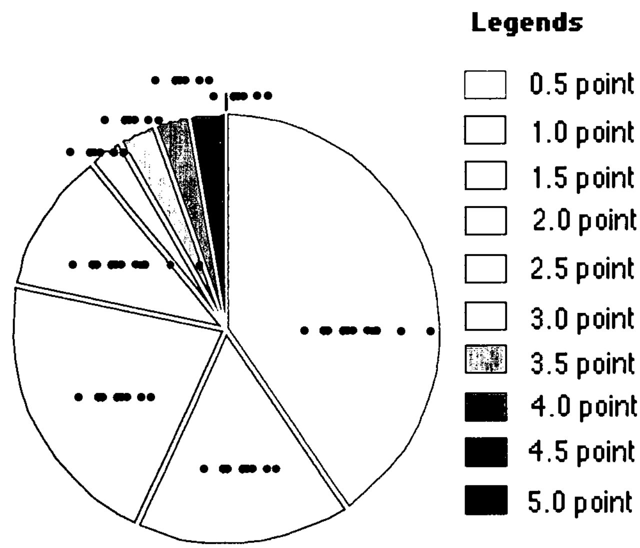


Fig. 6.



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